

Dual Fuel – A Lease Use Approach

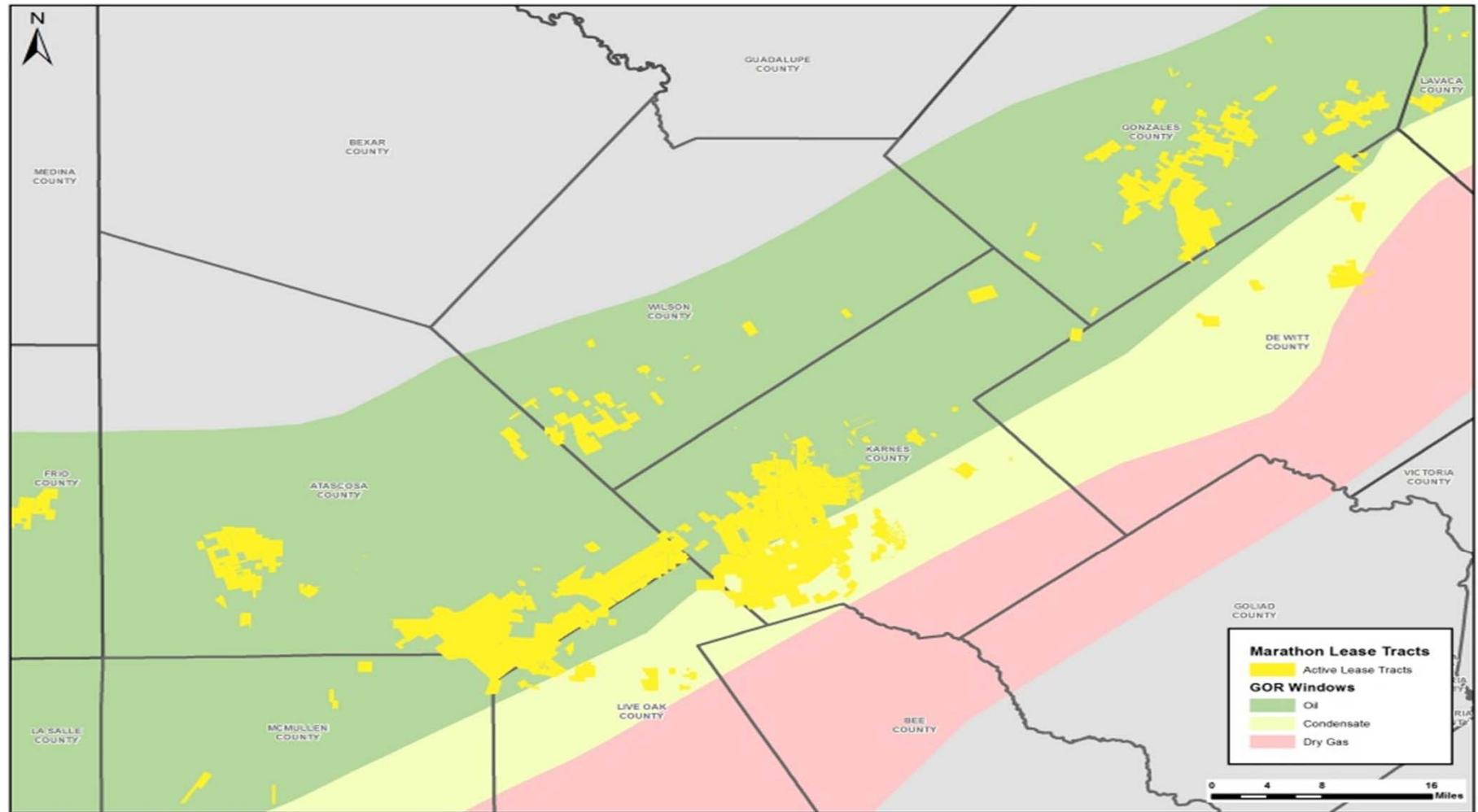
AADE Symposium – Feb 2014 – Tulsa, OK.



Marathon Oil®

Marathon Oil Corporation

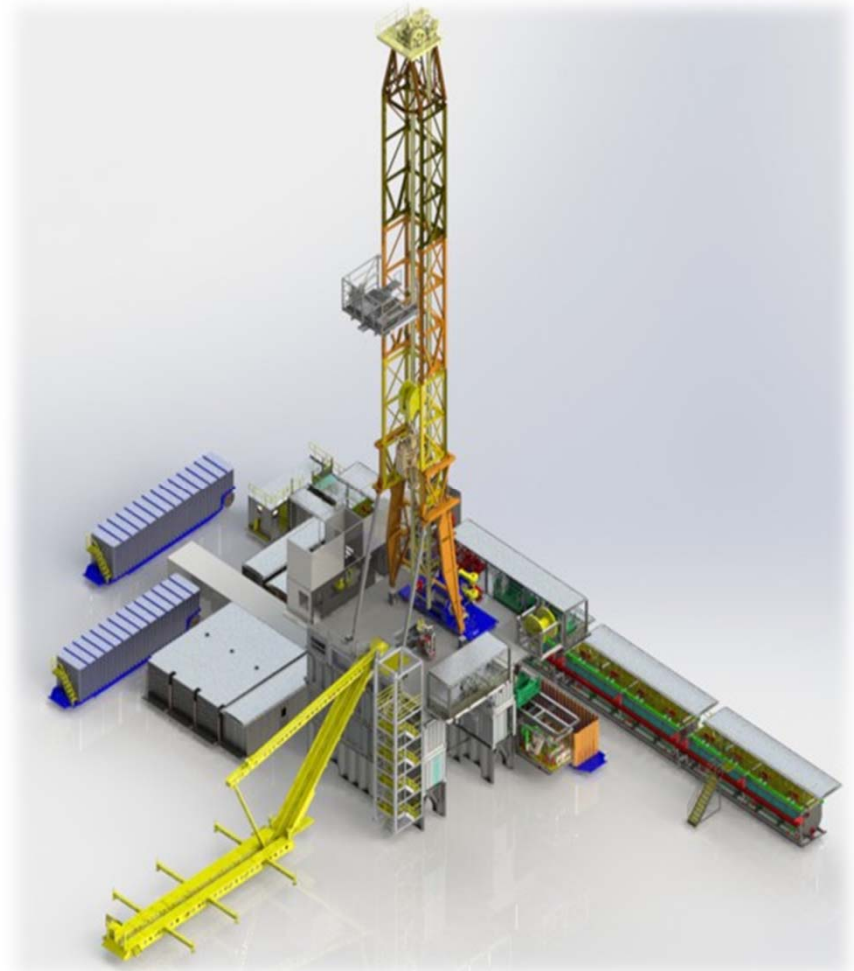
Eagle Ford Operations



Dual Fuel

Concept

- Substitute Natural Gas for Diesel Fuel
 - Economics
 - Diesel is ~10x the cost of natural gas on an MMBTU (energy-equivalent) basis.
 - Large spend category
 - Environmental Stewardship
 - Emissions Reduction
 - Trucking Reduction
 - Explore and Test Technology to advance Marathon's Eagle Ford Operations



Dual Fuel

Considerations and Challenges

- Land
 - Lease Terms
 - Permits
 - Pipeline Route
- Internal Communication
 - Division Order, Land, Law, Accounting, Measurement, Drilling, and Regulatory
- Safety
- Supply
- Rig Schedule
- Economics



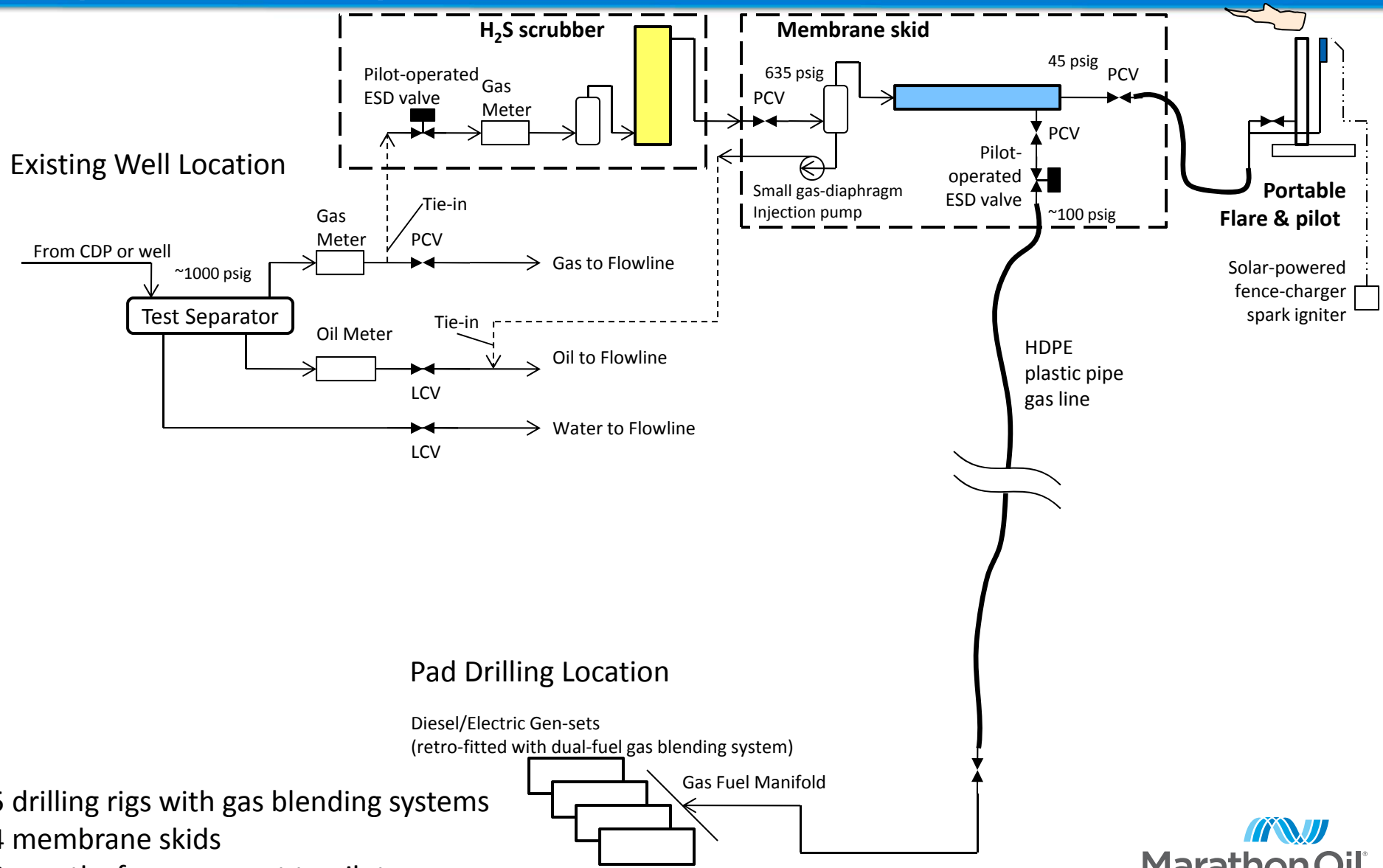
Dual Fuel

Supply Options

- LNG, CNG, Pipeline
 - Lack of Infrastructure and Supply
 - Commercial Terms
- Wellhead Gas
 - Eagle Ford gas is high in C4+ content which can result in pre-detonation
 - Requires pre-conditioning



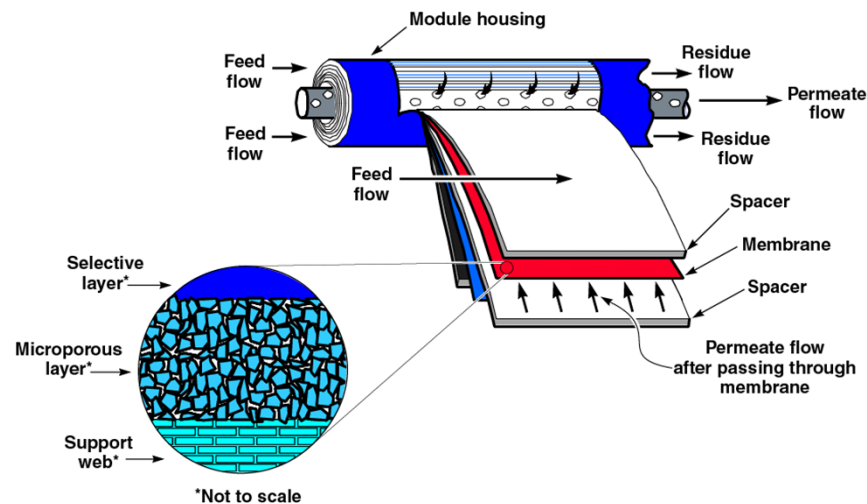
Dual Fuel Implementation Concept



5 drilling rigs with gas blending systems
4 membrane skids
8 months from concept to pilot

Dual Fuel

Membrane Technology



- Pressurized gas provides the driving force for heavy component permeation
- Passive operation with 99% reliability
- Operates at ambient temperature
- No upstream dehydration required
- Heavy components removed from gas are contained in a low pressure “permeate” vapor stream
- Combust permeate stream or recycle if location is near a central facility



Dual Fuel

Gas Blending

- Computer Controlled
 - Manages supply
 - Diesel is throttled back as gas is blended.
 - Up to 70% fuel replacement
 - Accepts LNG, CNG, Pipeline, and Field Gas
 - 900-1250 BTU
 - <10 PPM H₂S
 - 30 – 40 psi supply to inlet manifold
 - Proven Technology
 - Failure modes and response



Membrane Skid



Membrane Skid

PLC



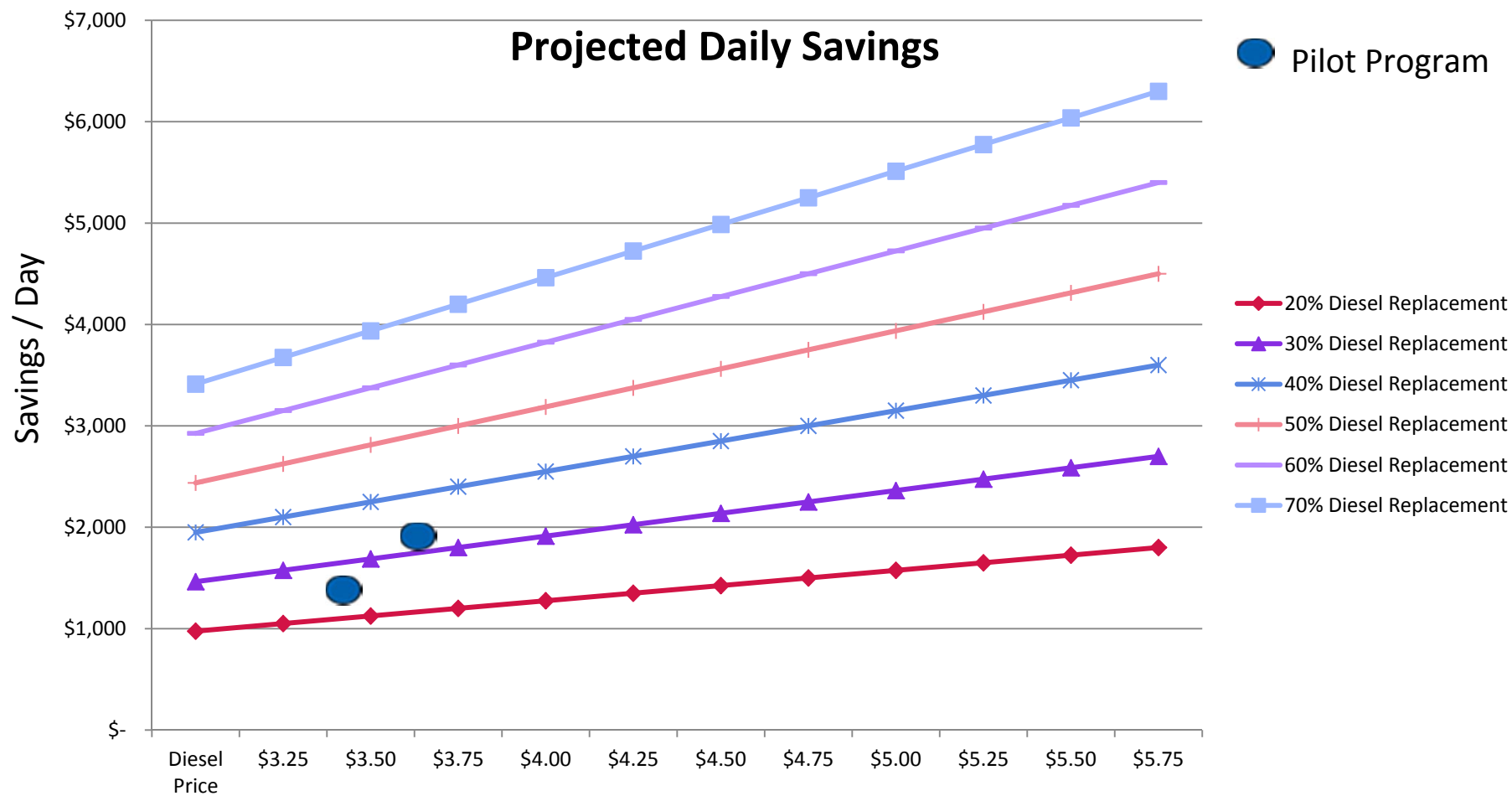
Membrane Skid

Control Valve



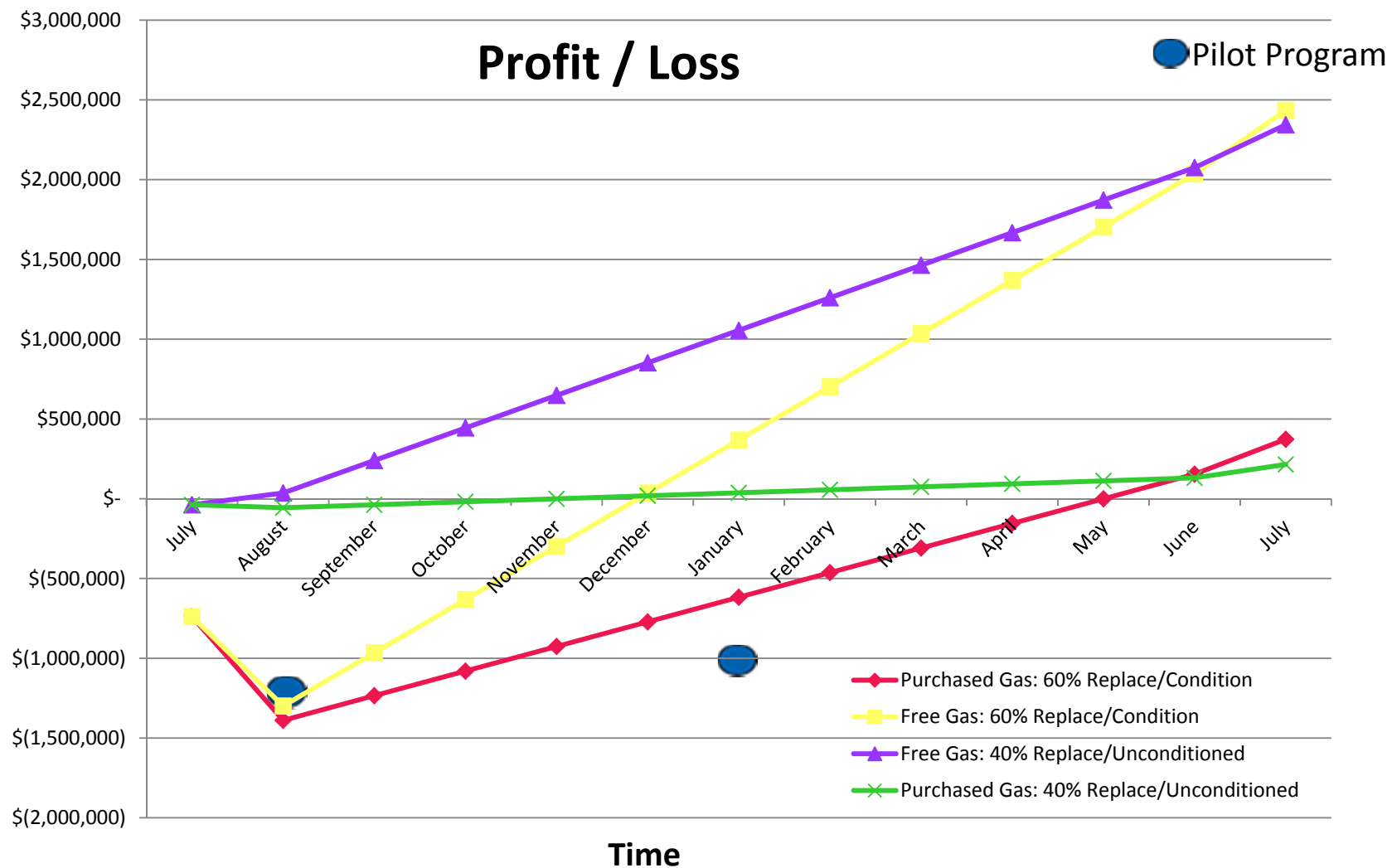
Dual Fuel

Fuel Savings



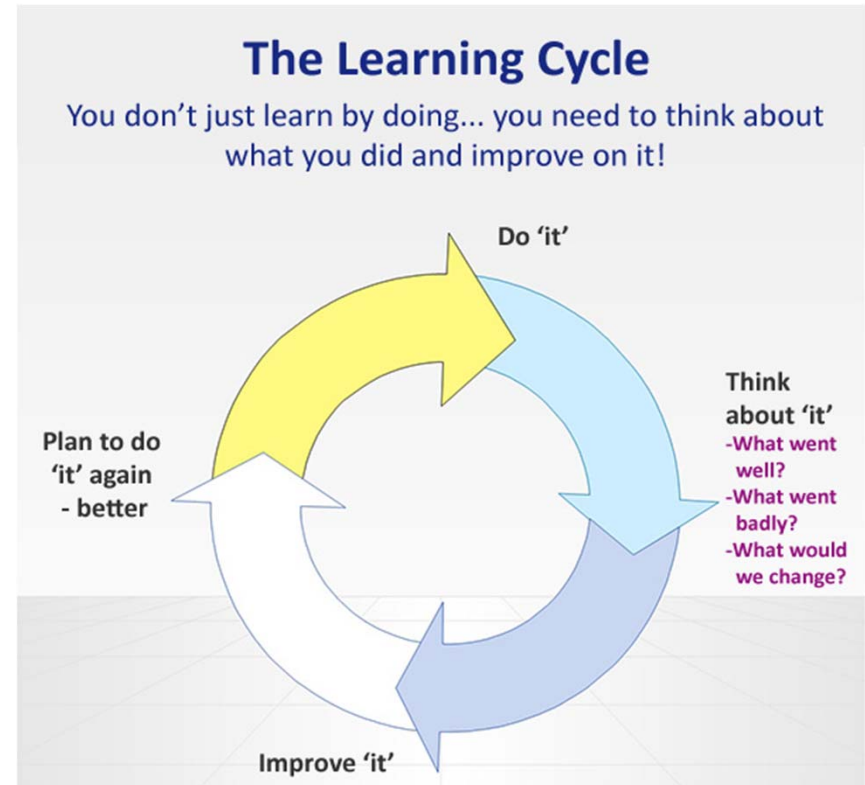
Dual Fuel

Profit and Loss



Lessons Learned, Going Forward

- Well Head gas is a viable solution
 - Eagle Ford gas provides challenges
- Equipment Uptime
 - Production upsets
 - Weather impacts
- Manpower Requirements
 - Long term “route” scenario
- Schedule Success
 - Viable locations, “set” rig schedule
- Expand and Drive Up Performance
 - Frac fleet and Compression sites



Questions?

Dual Fuel – A Lease Use Approach

AADE Symposium – Feb 2014 – Tulsa, OK.



Marathon Oil®

Marathon Oil Corporation